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COMPLETE SPECIFICATION

IMPROVEMENTS RELATING TO HEATING CIRCUITS

We, **SUNBEAM CORPORATION LIMITED,** a New Zealand company having a place of business at 1043 Tremaine Avenue, Palmerston North, New Zealand, hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

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This invention relates to electrical heating circuits, in particular but not solely to a circuit for electric blankets.

An electric current in a wire generates a magnetic field (commonly called emf) which may affect a nearby person's wellbeing. It is recommended internationally that a person be subjected to field strengths of no more than 2.5 milligauss (mG) except for very short periods of time.

A person lying on an electric blanket should generally be protected from fields generated by the heating current. This may be achieved by circuits in which current flows in both directions simultaneously along a two wire cable. The circuits should also employ overheat protection, and may be configured to draw negligible dc as is often required by electrical power regulations.

It is an object of the present invention to provide for reduction of emf in heating circuits or at least to provide the public with a useful choice.

Accordingly in one aspect the invention may broadly be said to consist in an electrical heating circuit comprising two terminals for input from an ac supply, and a cable having two conductors which effect heating held coextensively in proximity by a separating material of high resistance, wherein the conductors are connected at one end of the cable to respective terminals and at the other end to one another forming a current loop within the cable, and are configured so that their magnetic fields generated by current flow around the loop substantially cancel outside the cable, and wherein the loop includes half-wave rectifier means at each end of the cable which restrict ac to flow in one direction only during normal heating of the cable but are bypassed in the other direction during cable overheat, and sensor means through which bypass current flows during cable overheat to interrupt the circuit.

In a second aspect the invention may broadly be said to consist in a heating circuit comprising two terminals for input from an ac supply, and two arms each having two conductors which effect heating held coextensively in proximity by a separating material of high resistance, wherein the conductors of each arm are connected at one end to a respective terminal and at the other end to one another forming two current loops which pass current during alternate halves of an ac cycle, and wherein the conductors are configured so that their magnetic fields generated by current flow around the loops substantially cancel outside each arm.

Preferably the two arms are held together at their ends remote from the terminals to form a single loop of cable.

Preferably the circuit is substantially symmetrical with regard to ac flow so that dc flow is negligible.

A preferred embodiment is described in more detail as an example of the invention, with reference to the accompanying circuit diagram. Although this embodiment provides heating for an electric blanket, adaptation of the circuit for other uses is readily made.

The circuit comprises input terminals 10, optional overcurrent fuse 11 and resistor 12, thermal fuse 13 and two arms 14 and 15 connected as shown. The arms comprise heating conductor pairs 16, 17 and 18, 19 in respective cables, diodes 20, 21 and 22, 23, and resistors 24 and 25. The conductors are typically wires of about 850Ω total resistance for each arm separated by a positive temperature coefficient material 26 such as PVC. At normal temperatures PVC has a high impedance which falls with rising temperature approaching a melting point of around 160°C. The resistors are typically about 4.7 kΩ and each is placed physically close to the thermal fuse as indicated by the dash line. To avoid having free cable ends within a blanket, the arms may be fastened end to end within a common sheath.

The conductor pairs are helically wound into cable. First one conductor is wound on a polyester or like thread and coated with an intermediate layer of PVC. Then the other conductor is helically wound on the intermediate layer in the opposite sense to provide stability during temperature changes, and coated with an outer layer of PVC. Normally just one conductor of any such cable would be used for heating, with the other being provided only for overheat protection or for an alternative output power level. In use current then flows through terminals at each end of the cable. In the present invention however, the conductors are connected together at one end of each arm, preferably through a diode, so that current flowing along one conductor flows back along the other.

The conductors are not closely wound so their magnetic fields remain roughly those of straight wires. Their full lengths will generally be the same to reduce emf. Thus the inner conductor coils have smaller diameter and smaller pitch than those of the outer conductor.

Under normal operating conditions the terminals are part of a plug connected to mains power supply through a heat controller and current flows through one or other arm on each half of the ac cycle. Diodes 20, 21 and 22, 23 act as half-wave rectifiers for their respective arms. In one half cycle current flows through diode 20 bypassing resistor 24, then through conductor 16, diode 21 and conductor 17. During the other half cycle current flows through conductor 18, diode 22, conductor 19 and diode 23 bypassing resistor 25. Substantially equal and opposite currents flow simultaneously through the conductors in each arm so that emf outside the circuit is very low. Because of circuit symmetry created by the two arms a minimal dc component is drawn from the mains, although one arm may be omitted if the dc level is not important.

Cable faults such as a mechanical short circuit between the conductors of an arm or general overheating of the PVC, lower the impedance between the conductors allowing current to flow along part of each arm contrary to the normal direction. With a fault in arm 14

substantial current flows normally in one half cycle but then also in the other half between the conductors via material 26 and resistor 24. In arm 15 current may flow contrary to normal through resistor 25 and material 26. In each case the resistor is heated triggering the thermal fuse to open circuit and cease all current. In addition any fault in a cable causing excess normal flow will trigger the overcurrent fuse to open circuit and again cease all current.

On open circuit failure of any diode overheat protection is not lost. Failure of diode 20 or 23 will send current through resistor 24 or 25 to trigger the thermal fuse. Failure of diode 21 or 22 will prevent heating. On short circuit failure of diode 21 or 22 current passes through resistor 24 or 25 to trigger the thermal fuse. Overheat protection is only lost by short circuit failure of diode 20 or 23, which may be doubled for safety in this respect. The overcurrent fuse provides partial protection on failure of diode 20 or 23 against overheating in the power supply end of each arm.

WHAT WE CLAIM IS:

1. An electrical heating circuit comprising two terminals for input from an ac supply, and a cable having two conductors which effect heating held coextensively in proximity by a separating material of high resistance, wherein the conductors are connected at one end of the cable to their respective terminals and at the other end to one another forming a current loop within the cable, and are configured so that their magnetic fields generated by current flow around the loop substantially cancel outside the cable, and wherein the loop includes half-wave rectifier means at each end of the cable which restrict ac to flow in one direction only during normal heating of the cable but are bypassed in the other direction during cable overheat, and sensor means through which the bypass current flows during cable overheat to interrupt the circuit.

2. An electrical heating circuit according to claim 1 wherein the half-wave rectifier means includes a first diode in the connection between the conductors and a second diode of like polarity in one of the connections to a terminal.

3. An electrical heating circuit according to claim 2 wherein the sensor means includes a resistor connected in parallel with the second diode and a fuse sensitive to heat produced by current through the resistor to interrupt the circuit.

4. An electrical heating circuit according to any preceding claim wherein the resistance of the separating material falls with rising temperature and in regions of cable overheat allows current to flow directly between the conductors.

5. An electrical heating circuit according to any preceding claim wherein the conductors are wound as coaxial helices having widely pitched coils.

6. An electrical heating circuit according to any preceding claim wherein the conductors have substantially equal lengths.

7. An electrical heating circuit according to any preceding claim wherein the fields cancel to less than 2.5 mG outside the cable.

8. A heating circuit comprising two terminals for input from an ac supply, and two arms each having two conductors which effect heating held coextensively in proximity by a separating material of high resistance, wherein the conductors of each arm are connected at one end to a respective terminal and at the other end to one another forming two current loops which pass current during alternate halves of an ac cycle, and wherein the conductors are configured so that their magnetic fields generated by current flow around the loops substantially cancel outside each arm, and wherein the current loop in each arm includes half-wave rectifier means at each end of the arm which restrict ac to flow in one direction only during normal heating but are bypassed in the other direction during overheating, and sensor means through which bypass current flows during overheating to interrupt the circuit.

9. A heating circuit according to claim 8 wherein the half-wave rectifier means in each arm includes a first diode in the connection between the conductors and a second diode of like polarity in one of the connections to a terminal, and wherein corresponding diodes in the two arms have opposite polarity, so that the arms pass current alternately during the ac cycle.

10. A heating circuit according to claim 9 wherein the sensor means includes, in each arm, a resistor connected in parallel with the second diode and also includes a fuse sensitive to heat produced by current through either resistor to interrupt the circuit.

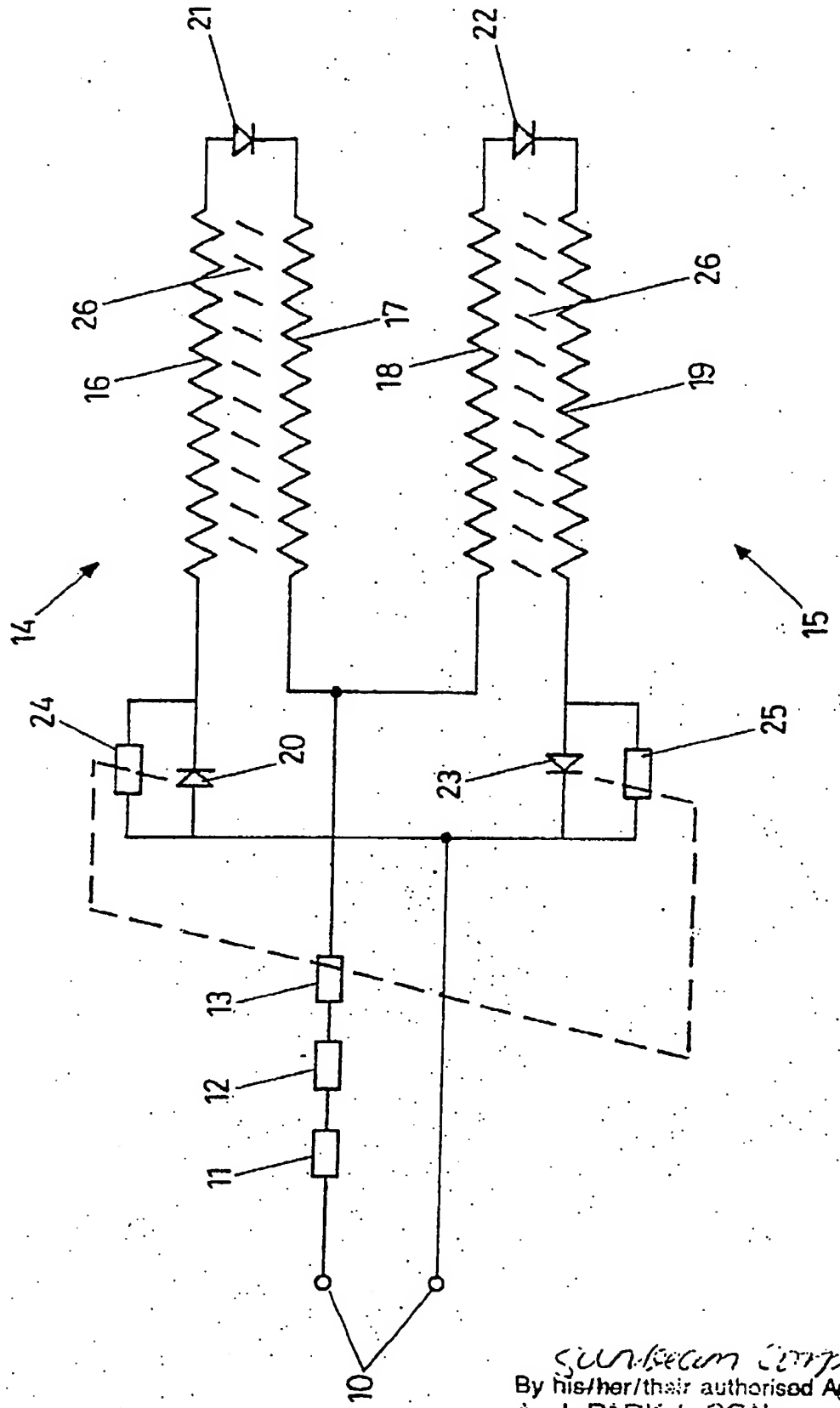
11. A heating circuit according to any one of claims 8 to 10 wherein the two arms are separated along their lengths but held together at their ends remote from the terminals to form a single loop of cable.

12. A heating circuit according to any one of claims 8 to 11 wherein the circuit is substantially symmetrical with regard to ac flow through each arm so that dc flow is negligible in the circuit overall.

13. An electrical heating circuit having two conductors which effecting heating substantially as herein described with reference to the accompanying drawings.

14. A heating circuit having two arms each having two conductors which effect heating substantially as herein described with reference to the accompanying drawings.

DATED THIS 22 DAY OF August 95
A. J. PARK & SON
PER J. Newlap
AGENTS FOR THE APPLICANTS



Sunbeam Corporation Limited
By his/her/their authorised Agents
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PER .....